

REMARKS

In view of the above amendments and following remarks, reconsideration of the rejections contained in the Office Action of June 30, 2005 is respectfully requested.

A number of minor editorial changes have been made to the specification to generally place the present application into better form. These have been presented in the form of a substitute specification. No new matter has been entered.

In the Office Action, the Examiner rejected claims 1, 17, 19 and 22 as being anticipated by Gorman et al., U.S. Patent 6,858,334 (Gorman). Claims 1, 5, 7, 9, 11, 17, 19 and 21-23 were rejected as being anticipated by Subramanian, U.S. Patent Publication 2003/0211354 (Subramanian). Further, claims 1-4 and 17-22 were rejected as being anticipated by Rickerby et al., U.S. Patent 6,025,078 (Rickerby). Lastly, claims 1-23 were rejected as being unpatentable over Rickerby in view of Subramanian. However, it is respectfully submitted that the present invention, particularly as now reflected by new claims 24-42, clearly patentably distinguishes over each of Gorman, Subramanian and Rickerby.

The object of the present invention is to provide a thermal barrier coating that hardly peels off even when used at high temperature, particularly when used for a turbine part in a gas turbine. A primary aspect of the present invention involves employing zirconia stabilized by ytterbia. This provides a crystal line stability that is excellent with high temperatures as compared with conventional ceramics.

Further, it is preferable that the ceramics layer have cracks that extend in a thickness direction of the ceramics layer introduced therein. By intentionally introducing cracks that elongate or extend in the ceramics layer thickness direction, stress that acts on the ceramics layer, which has a smaller thermal expansion coefficient as compared with the base material and is poor in ductility, can be mitigated, and a ceramics layer in which peeling is hardly ever caused can be obtained. Note for example the discussion beginning at page 7 of the original specification. Also note the description of Fig. 3 beginning at the middle of page 18 of the original specification.

Cracks 23a are formed in ceramics layer 23 so as to elongate or extend in the coating thickness direction. These cracks are intentionally introduced at the time of forming the ceramics layer 23 in order to enhance the anti-peeling ability of the ceramics

layer 23. It is preferable that the cracks 23a are introduced in the ceramics layer 23 so as to extend in the direction normal to a face of the ceramics layer 23. However, if they extend within an angle range of $\pm 40^\circ$ relative to the normal line, a sufficient effect to prevent the ceramics layer 23 from peeling can be obtained. A corollary of this aspect is also of course that there is no intent to introduce cracks outside of this range.

The effect of the introduction of cracks is demonstrated by Table 2. With the addition of ytterbia, and cracks being introduced, the thermal life cycle can be greatly increased. Note for example the comparison with Table 1.

Thus, the intentional formation of cracks within the indicated range results in a thermal barrier coating arrangement having a high thermal cycle life, and with a remarkably enhanced thermal cycle durability.

Gorman is directed to ceramic compositions for low conductivity thermal barrier coatings, and optionally uses ytterbia. However, Gorman does not address the presence of cracks to mitigate thermal stress.

Subramanian has the object of providing a material that is hard sintered in order that the ceramics layer is provided with an abradable characteristic. Enhancement of the thermal cycle durability is not an object. In paragraph 20 on page 2 of Subramanian, it is discussed that the thermal barrier coating 10 may include voids 18 including generally spherical or other shape pores, generally horizontal cracks or defects, and generally vertical cracks or defects. These are generated by a differential thermal expansion during deposition and volatilization of a fugitive material 19. However, there is no limitation put upon the direction of the cracks, and it can include both horizontal and vertical cracks, as described.

However, cracks in the plane direction of the ceramics layer do not contribute to mitigation of thermal stress. Rather, they may cause peeling of the ceramics layer.

Claim 24 specifically requires that the cracks are introduced into the ceramics layer such that they extend and arrange $\pm 40^\circ$ relative to the normal line to a face of the ceramics layer, and not outside the range. Thus, Subramanian clearly does not anticipate or render obvious claim 24.

Claim 42 is similar to claim 24, but recites the thermal barrier coating arrangement, with respect to the cracks, more in a product-by-process format. This claim

recites intentionally introducing cracks into the ceramics layer that extend in a thickness direction of the ceramics layer in a range of $\pm 40^\circ$ relative to the normal line to a face of the ceramics layer, and not intentionally introducing cracks outside of the range. Subramanian intentionally introduces cracks outside of the claimed range, and thus does not meet the limitations of claim 42.

Independent claim 40 is directed to a manufacturing method of the thermal barrier coating. It includes the step of introducing cracks into the ceramics layer when the thermal spraying process is carried out using a thermal spraying powder. While Subramanian discloses a thermal spray deposition process, it employs a fugitive material 19. It does not introduce cracks into the ceramics layer when the thermal spraying process is carried out using a thermal spraying powder as recited in claim 40.

The cited patent to Rickerby has the object of reducing thermal conductivity, and not of enhancing thermal cycle performance. It does not discuss cracks, and it does not, in particular, address mitigation of thermal stress by the presence of cracks.

There are a number of additional differences between the claims of the present invention and the references cited by the Examiner. However, at this point it does not appear to be necessary to go into further detail regarding such distinctions. Applicants reserve their right to address all such distinctions as may be appropriate at any later point in time.

In view of the above it is respectfully submitted that all of the claims now pending in the present application clearly distinguish over the references cited by the Examiner. Indication of such is respectfully requested.

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance, and the Examiner is requested to pass the case to issue. If the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact Applicants' undersigned representative.

Respectfully submitted,

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